How well can the EMEP model reproduce size segregated PM chemical composition data collected in the EMEP intensive measurement period in June 2006?

Norwegian Meteorological Institute

Svetlana Tsyro, Wenche Aas, Karl Espen Yttri, Cinzia Perrino and Gerald Spindler

Objectives. Particulate Matter (PM) is a complex pollutant with a heterogenic chemical composition. The chemical composition of the PM carries information about PM sources. An accurate representation of the PM chemical composition by air quality models is necessary for reliable calculations of PM source allocation.

Presented here are the preliminary results of a comparison between modelled and observed chemical composition of PM10 and PM2.5. Calculations were made with the EMEP Unified model (EMEP, 2003). The observations were made during the EMEP intensive measurement period conducted in June 2006.

*) **EMEP** - Co-operative Programme for monitoring and evaluation of the long range transmission of air pollutants in Europe

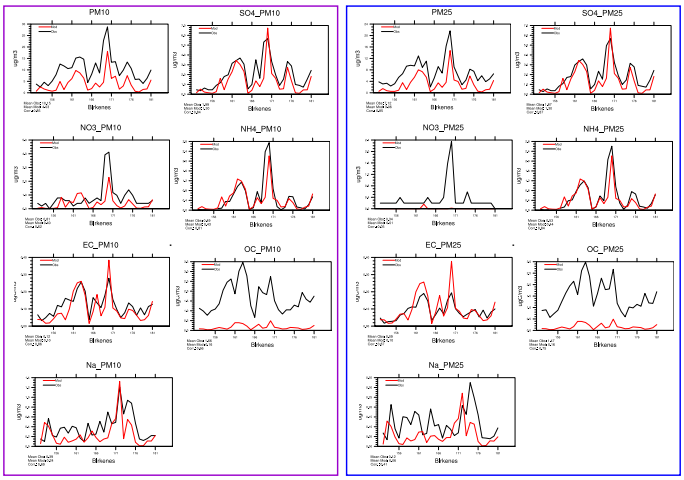
The EMEP Unified model (Simpson et al., 2003; Tsyro, 2005) describes the emissions, chemical transformation, transport and dry and wet removal of atmospheric aerosol and its gaseous precursors. The model accounts for both anthropogenic and natural aerosols and calculates seven PM components: SO_4^{2-}, NO_3^-, NH_4^+, organic carbon (OC), elemental carbon (EC), sea salt and mineral dust; and particle water.

Anthropogenic emissions of gaseous aerosol precursors and primary PM are from the EMEP emission database. Natural particle sources are sea spray and soil dust production by wind erosion.

Measurement data are those collected during the EMEP intensive measurement period in June 2006. Model results have been compared with measurements at three sites, namely Birkenes (Norway), Melpitz (Germany) and Montelibretti (Italy).

Birkenes (NO01)

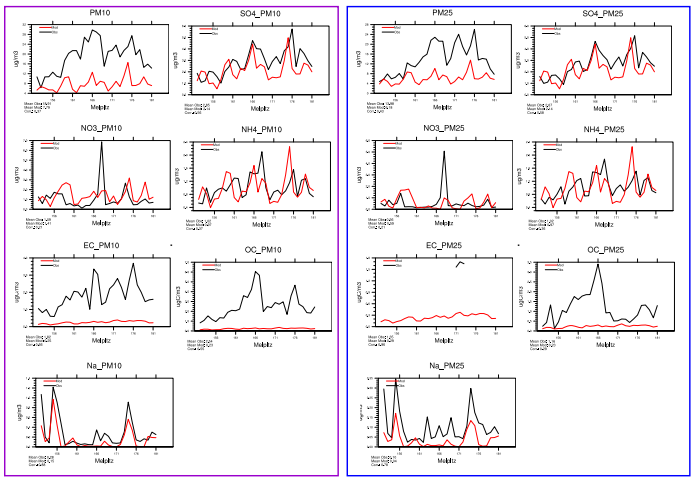
PM10 | PM2.5



NO01: Large underestimation of OC. Note: only primary anthropogenic OC in the model; correction for positive artefacts would lower OC_PM10 and OC_PM2.5 by about 40 and 50%. SO4 and NO3 are underestimated by around 30-35%; and practically no fine NO3 in model results (too large shift towards the gas-phase equilibrium in summer?). In general good correlation.

Melpitz (DE44)

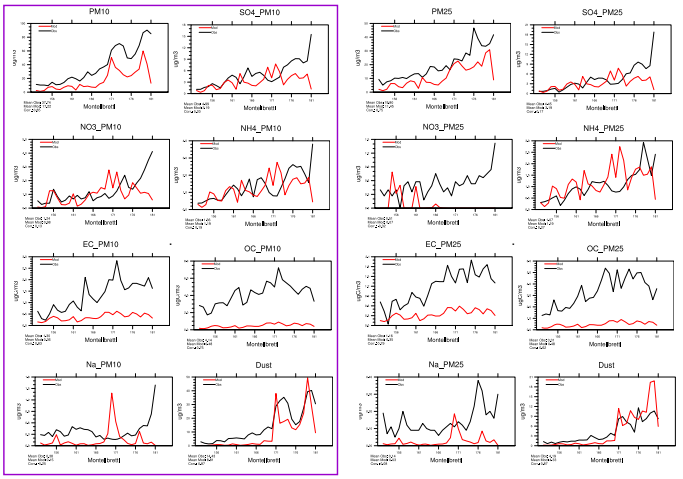
PM10 | PM2.5



DE44: Large model underestimation of EC and OC. Note: only primary anthropogenic OC in the model; OC was not corrected for positive artefacts. Reasonable results for SO4 and NO3 – within 25% of observations. Na is underestimated, especially Na_PM2.5. Mixed correlation results.

Montelibretti (IT01)

PM10 | PM2.5



IT01: Large model underestimation of EC and OC (only primary anthropogenic OC in the model). Reasonable results for SO4 and NO3 – within 25% of observations. Modelled SO4, NO3, NH4 are within 30% of observations. Na is considerably underestimated; Note: almost no correlation between measured Na_PM10 and Na_PM2.5. Good correlation for EC and OC, whereas rather poor for SIA and Na. **Fairly good results for mineral dust!**

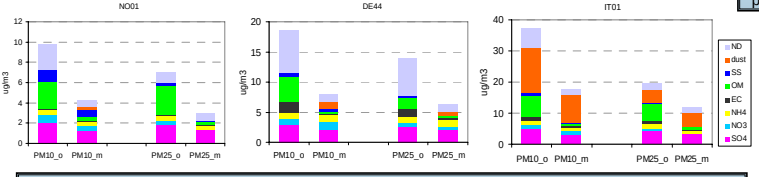
Model vs. measurements: NO01, DE44 and IT01. June 2006.

Comp.	Obs	Mod	Bias	R
PM_{10}	15.18	7.57	-50	0.77
SO_4^{2-}	3.41	2.18	-36	0.44
NO_3^-	1.07	0.91	-14	0.27
NH_4^+	0.99	0.85	-15	0.48
EC	0.60	0.22	-63	0.42
OC	1.99	0.35	-82	0.24
Na	0.36	0.18	-50	0.41
Crustal*)	14.59	8.30	-43	0.85

Comp.	Obs	Mod	Bias	R
$PM_{2.5}$	9.27	5.6	-40	0.66
SO_4^{2-}	3.10	2.18	-30	0.40
NO_3^-	0.47	0.22	-54	0.18
NH_4^+	1.06	0.86	-20	0.50
EC	0.35	0.21	-41	0.51
OC	1.45	0.34	-77	0.30
Na	0.12	0.04	-66	0.37
Crustal*)	4.13	4.08	-1	0.87

*) Determined only at Montelibretti

Observeded and modelled chemical composition of PM10 and PM2.5. June 2006



Considerable fraction of PM2.5, and in particular PM10, remains undetermined in the measurements (ND); in model results ND is the particle water. Note: OM=1.7xOC (OC measurements were corrected for artefacts at IT01, but not at NO01 and DE44).

Summarising preliminary results...

Analysis of calculation and observation results for all aerosol components in PM2.5, PM10 and PM10-2.5 has been made, which contributes to our understanding of the model performance for PM.

The model underestimates PM10 by 50% and PM2.5 by 40% for the three sites for June 2006. The largest underestimation is found for OC, largely because secondary OC is not included in the model yet. This can be identified as the main reason for model general PM underestimation, which is contributed by SO4 model underestimation by about 30%. For other components, the results are mixed, and EC, fine NO3- and sea salt aerosols are often under-predicted. The correlation between modelled and measured PM components shows a tendency to worsen from north (NO01) toward south (IT01).

References:

Simpson, D, Fagerli, H, Jonson, J. E., Tsyro, S. and Wind. P. (2003). EMEP Status Report 1/2003, Part I.

Tsyro, S. (2005). In: Transboundary particulate matter in Europe. EMEP Status Report 4/2005.

EMEP (2007a). EMEP/CCC Report 8/2007. Norwegian Institute for Air Research, Kjeller, Norway.

EMEP (2007b). EMEP/CCC&MSC-W Status Report 4/2007. Norwegian Institute for Air Research, Kjeller, Norway.

All reports can be found on http://www.emep.int.

Contact: ***Svetlana Tsyro***

Norwegian Meteorological Institute
Research and Development Division
P.O. Box 43 Blindern, N-0313 Oslo

e-mail: svetlana.tsyro@met.no
Phone: +47 22 96 33 01
Website: http://www.emep.int

Norwegian Meteorological Institute http://www.met.no

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